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Simultaneous and consecutive operation comparison in bilateral hallux valgus surgery

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Abstract
Aim: This study aims to determine whether simultaneous bilateral hallux valgus surgery is advantageous over consecutive operations.
Material and Methods: Patients who underwent bilateral hallux valgus surgery were separated into groups Group A and B. Group A included patients who underwent simultaneous bilateral hallux valgus surgery, and Group B who received the consecutive hallux valgus surgery using a Modified Chevron osteotomy techniques with mini-incision. Clinical and radiological databases, complications, mean costs of analgesic drugs, the duration time of surgical operations, the length of hospital stay, the cost of implants, the cost of each group, hospital costs for each patient were determined. The mean in FAOS (Foot and Ankle Outcome Score) scores were calculated for both groups postoperatively.
Results: Patients with bilateral hallux valgus (n=175) were chosen among the hallux valgus patients (n=479). Of these, bilaterally operated patients were accessible about 2/3 (n=101). In Group A (n=30), there were 21 females and 9 males, aged 22–58 years (mean 41.45±15.12). In Group B (n=35), there were 27 females and 8 males, aged 27–61 years (mean 45.33±12.64). There was no significant difference in demographic characteristics ($p \leq 0.449$) and the follow-up time ($p < 0.05$) between the two groups. The mean hospitalization duration was also shorter in Group A ($p \leq 0.001$).
Discussion: Our results demonstrated that simultaneous bilateral hallux valgus surgery is statistically cheaper than consecutive bilateral hallux valgus operation. But, FAOS had slightly better courses in the consecutive bilateral hallux valgus operations compared to simultaneous bilateral hallux valgus operations.

Keywords
Hallux Valgus, Bilateral, Simultaneous, Consecutive, Cost-Effectiveness

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Introduction

In the literature, many studies have evaluated bilaterally versus unilateral surgery in orthopedics; however, the number of studies comparing outcomes of bilateral versus unilateral foot surgery is limited [1, 2]. In 2009, Fridman et al compared unilateral versus bilateral first ray surgery in a prospective study of 186 consecutive cases according to patient satisfaction, costs, and complications [1]. Lim WSR et al. demonstrated that simultaneous minimally invasive percutaneous surgery (MIS) was suitable for patients with bilateral hallux valgus [3]. Seo JH et al. declared that distal Chevron Metatarsal Osteotomies (DCMO) in elder patients (≥60 years), even one-stage bilaterally, were effective and safe [4].

In this retrospective cross-sectional study, a comparison between outcomes of one-stage bilateral procedures versus consecutive surgeries for bilateral HV was performed. The main objective of this study was to detect costs, complications and outcomes associated with both surgical approaches for bilateral HV. The clinical and radiological outcomes of the patients who underwent one-stage and consecutive HV surgeries were retrospectively analyzed and compared. Our research aims to detect both functional outcomes and cost-effectiveness.

Material and Methods

Databases of all patients who underwent HV surgery were extracted from the hospital archive records between November 2017 and April 2019. Simultaneous bilateral HV surgery was only applied in those patients who volunteered for this procedure with a patient consent form. In the decision for simultaneous surgery following conditions were taken into account: i) consent of the patient, ii) good general health of the patient. The power analysis for the sample size was provided. Patients were separated into groups Group A and B. Group A included those patients who underwent one-stage HV surgery and Group B included those patients who received consecutive HV surgeries. A clinical researcher, who was blinded to the study, collected all information from the databases.

All patients were evaluated for surgical contraindications in ordinary local routines. All patients were exposed to the same pre-operative protocols and imaging studies for bilateral HV surgery. A single senior surgeon performed all procedures using medial, over the web skin incisions for each osteotomy. Modified Chevron osteotomy techniques with mini-incision and tourniquets were applied for all patients [5].

Standard second-generation cephalosporin antibiotic treatment regimens were given to all patients before and after surgery. The same preoperative and postoperative care conditions were provided for all patients. Clinical and radiological databases were set up to evaluate patients in both groups. Clinical trials were done at the sixth month, and the first year for all patients in both study groups. For clinical follow-up assessments, x-rays images were collected for radiologic evaluation. Outcomes of demographic features consisted of age (year), gender, and frequency. The outcomes of clinical evaluation are preoperative risk evaluation (ASA grading), operation duration (min), hospitalization duration (TL), postoperative pain scoring (VAS), analgesic need (several times), analgesia cost (TL), implant counts (TL), implant cost (TL), total duration in operation theatre (min), invoice (TL), immobilization duration (min), the mean in FAOS (Foot and Ankle Outcome Score) values. FAOS consists of pain, activities of daily living, sport and recreational activities foot and ankle related quality of life (QOL), and other symptoms. The outcomes of radiological evaluation are the HV measurements. It includes HVA, IMA, distal metatarsal articular angle (DMAA), proximal phalangeal articular angle (PPAA). Complications during postoperative periods were recorded. Mean FAOS (Foot and Ankle Outcome Score) scores related to pain, activities of daily living, sport and recreational activities, foot and ankle related QOL (Quality of Life) and other symptoms were calculated for both groups in the postoperative sixth month and during the first year of clinical follow-up [6,7]. A special rehabilitation team was established for the postoperative rehabilitation of these patients. This program was carried out in a very controlled manner for patients, especially in a single session. Some patients in the single session group were mobilized by loading onto the heels with a walker. The remaining patients were mobilized with a wheelchair. The special program for all patients was applied. This program consisted of passive and active exercise chains. Passive and active exercise chains are that the programs were carried out by placing the loading on the heel (with a walker providing contact from multiple points to the ground) under the control of Physical Therapy and Rehabilitation physicians and physiotherapists in our hospital.

SPSS® versions 20 statistical software (SPSS Inc., Windows®, IL, USA) was used. Independent sample tests and Mann-Whitney U tests were used for all parameters. A p-value less than 0.05 was considered statistically significant.

Results

Overall, 175 patients were diagnosed with bilateral HV and 101 of the 175 patients were operated on for bilateral HV over a 3-years period. Overall, 30 patients underwent one-stage HV surgery (Group A) and 35 patients underwent consecutive HV surgeries (Group B). Some of the 36 patients could not be

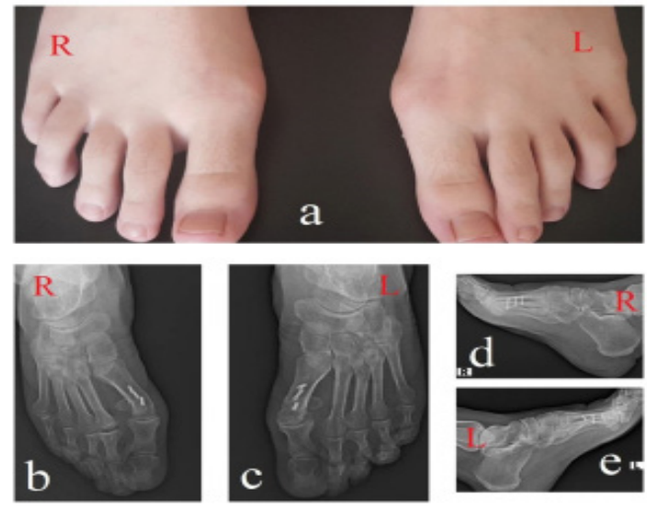

Figure 1. a) Clinical view of the right and left hallux valgus, b-c) postoperative antero-posterior x-ray of a patient in the one-stage HV surgery group, d-e) postoperative lateral x-ray of a patient in the one-stage HV surgery group. (R: right, L: left).

included in the study group because they did not meet the inclusion criteria, some did not want to participate in the study, and some of them had problems in patient follow-up. Bilateral modified Chevron osteotomies with mini-incision (<4 cm) were performed for patients who had bilateral HV in a single surgical session (Group A) versus those who had the procedure in consecutive surgical sessions (Group B) (Figure 1).

The demographic, clinical, and surgical characteristics of both groups are demonstrated in Table 1. There was no significant difference between the groups for gender and age distribution. The mean in age was 41,45±15,12 years [median 50,0 years (22-58)] in Group A, and 45,33±12,64 years [median 47,5 years (27-61)] in Group B. The mean in age (year) was 41.7±11.36 in female patients in Group A, 40.9±13.86 in male patients in Group A; and 40.9±10.96 in female patients in Group B, 41.6±12.57 in male patients in Group B. There was no statistical difference between two groups and genders. There was no significant difference in all demographic characteristics (p≤0.449). ASA grades were similar between the two groups (I or II). The mean duration of follow-up was also similar between the two groups

Table 1. Demographic features, preoperative and postoperative parameters of study groups.

Groups	mean age (years according to gender)	Values	Age (year)	Preoperative Risk Evaluation (ASA grading)	Operation duration (min)	Hospitalization duration (TL)	Postoperative pain scoring (VAS)	Analgesic Needs (several times)	Analgesia Costs (TL)
Group A (Simultaneous Bilateral) (Female: 8, Male: 3)	Female: 41.7±2.36	Mean	41.45	4.55	126.00	Şub.91	54.091	4.73	1.55
		Median	50.00	4.00	125.00	3.00	47.600	5.00	2.00
		Std. Deviation	15.129	1.368	14.832	0.701	162.849	1.272	0.522
		Minimum	22	3	101	2	35,7	2	1
	Male: 40.9±3.86	Maximum	58	7	151	4	83,3	6	2
		Percentiles	25.0	1.00	119.00	2.00	4.00	3.00	35.700
			50.0	2.00	125.00	3.00	5.00	4.00	47.600
			54.0	2.00	138.00	3.00	6.00	6.00	71.400
Group B (Staged) (Female: 9, Male: 3)	Female: 40.9±1.96	Mean	45.33	9.67	245.17	5.58	115.033	8.33	1.50
		Median	47.50	9.50	251.50	5.00	113.050	8.50	1.50
		Std. Deviation	12.644	1.923	34.314	1.564	228.807	1.723	0.522
		Minimum	27	6	193	4	71,4	6	1
	Male: 41.6±2.57	Maximum	61	13	315	9	154,7	11	2
		Percentiles	34.25	1.00	212.00	4.25	7.00	9.00	107.100
			47.50	1.50	251.50	5.00	8.50	9.50	113.050
			58.25	2.00	263.50	6.00	10.00	11.00	130.900

Table 2. Preoperative and postoperative cost amounts of the study groups

Group		Implant counts (TL)	Implant costs (TL)	Total duration in opration theatre (min)	Invoice (TL)	Immobilization duration (min)
Group A (Simultaneous Bilateral)	Mean	4.73	160.82	1044.73	1438.27	5.55
	Median	5.00	165.00	1105.00	1275.00	6.00
	Std. Deviation	1.348	16.241	297.996	287.197	0.934
	Minimum	2	134	442	1147	4
	Maximum	7	181	1547	1881	7
Group B (Staged)	Mean	5.58	281.42	1233.92	2848.42	10.83
	Median	6.00	281.50	1326.00	2770.50	11.50
	Std. Deviation	0.793	31.942	175.244	463.455	1.850
	Minimum	4	241	884	2392	7
	Maximum	7	350	1547	3670	13

Table 3. The FAOS scores in groups

	Group A (Simultaneous Bilateral)		Group B (Staged)	
Months	6th Month	1st Year	6th Month	1st Year
Pain	31 (SD 18.2)	29 (SD 19.4)	29 (SD 19.8)	28 (SD 18.6)
Activities of Daily Living	31 (SD 12.4)*	52 (SD 13.8)**	37 (SD 13.8)*	54 (SD 13.4)**
Sport and Recreational Activities	23 (SD 19.3)*	25 (SD 22.1)**	27 (SD 17.6)*	31 (SD 18.6)**
Foot and Ankle related QOL	29 (SD 17.7)*	31 (SD 29.6)**	32 (SD 23.4)*	47 (SD 28.7)**
Other Symptoms	13 (SD 11.3)	29 (SD 19.7)	19 (SD 12.2)	30 (SD 19,9)
Statistics	*(p≤0.05)	**(p≤0.004)	*(p≤0.05)	**(p≤0.004)

(p<0.05). In Group A, there were 21 females and 9 males, aged 22–58 (mean 41.45±15.12) years. In Group B, there were 27 females and 8 males, aged 27–61 (mean 45.33±12.64) years. Significant differences were detected between the two groups for mean operative time, length of stay and hospital charges (p≤0.001). The mean total anesthesia duration was shorter in Group A than in Group B (p≤0.001). The mean hospitalization duration was also shorter in Group A (p≤0.001).

The mean total cost differences between the groups are demonstrated in Table 2. All total costs were lower in Group A than in Group B (p≤0.001). The median length of hospital stay in Group A was 2.91±0.70 days, while that in Group B, it was 5.58±1.56 days. The mean analgesia costs were 54.09±16.28 TL (Turkish Liras) in Group A and 115.03±22.88 TL in Group B (p≤0.001). The mean implant costs in Group A were 1044.73±297.99 TL and 1233.92±175.24 TL in Group B (p≤0.091). The mean anesthesia costs were 1438.27±287.19 TL in Group A, 2848.42±463.45 in Group B (p≤0,000). The mean total hospitalization costs were 2536.09±200.49 TL in Group A and 4197.37±220.52 in Group B (p≤0.001). This indicates that total hospitalization costs were approximately two-fold higher in Group B (p≤0.001). The one-stage procedure was relatively lower in costs as it was 60.42% less in total hospital costs.

When considering the mean values of hallux valgus correction rates, the comparison of the postoperative and preoperative radiographic changes was significant in both groups (p<0.05). There was no significant difference between the groups for complications in the sixth month and the first year of follow-up (p>0.05). As surgery-related complications, one superficial infection was detected in the first year in Group A, and one superficial infection in the sixth month and a deep wound infection in the first year were detected in Group B. As time-related complications, there were no complications in both groups in the sixth-month follow-up. On the first-year follow-up, one fixation failure was detected in the first year in Group A, and two complications as one fixation failure and the other one was wound detachment were detected in Group B. In the other complications, dizziness was detected in the first year in Group A, depression was detected in the first year in Group B, but the relationship of both complications with the surgery was not clear.

Both groups used short leg splint for 6 weeks after each surgery subsequently. The mean FAOS (Foot and Ankle Outcome Score) scores were for pain, activities of daily living, sport, and recreational activities, foot and ankle related QOL and other symptoms respectively 31 (SD 18.2), 31 (SD 12.4), 23 (SD 19.3), 29 (SD 17.7), and 13 (SD 11.3) in Group A and 29 (SD 19.8), 37 (SD 13.8), 27 (SD 17.6), 32 (SD 23.4), and 19 (SD 12.2) in Group B in the sixth month follow-up. The mean FAOS (Foot and Ankle Outcome Score) scores for pain, activities of daily living, sport and recreational activities, foot and ankle related QOL and other symptoms respectively 29 (SD 19.4), 52 (SD 13.8), 25 (SD 22.1), 31 (SD 29.6), 29 (19.7) in Group A and 28 (SD 18.6), 54 (SD 13.4), 31 (SD 18.6), 47 (SD 28.7), 30 (SD 19,9) in Group B in the first year of follow-up. When comparing scores as time-related, there was a significant difference for activities of daily living, sport, and recreational activities and foot and ankle related QOL in Group B compared to Group A, respectively (p≤0.05) and (p≤0.004). FAOS scores were shown in Table 3.

Postoperative rehabilitation procedures were the same in the two groups. All patients were evaluated for successful range of motion (ROM) at the final follow-up. There was a significant difference in mean analgesic costs between the two groups (p≤0.001).

Discussion

In our study, the simultaneous bilateral procedure resulted in a lesser duration of anesthesia and hospitalization. The simultaneous bilateral operation also had significantly lower costs. Besides, consecutive surgical operations were significantly more expensive than one-stage operations. The simultaneous bilateral HV surgery had shorter hospitalization, less total anesthetic time, and greater economic advantages compared to the consecutive HV surgery. Simultaneous bilateral HV surgery had shorter operative and anesthetic times, possibly due to mismanagement of time among auxiliary health personnel involved in the consecutive operations. In Group A, the length of hospital stay was shorter and faster rehabilitation was observed. The biomechanical outcomes of these two groups were not significantly different. FAOS scores were better for activities of daily living, sport and recreational activities and foot and ankle related QOL in Group B compared to Group A in the sixth month and in the first year of follow-up.

Simultaneous bilateral procedure deserves to be investigated for the following reasons: i) simultaneous bilateral procedure reduces surgery and hospital costs, ii) with the operation performed in a single session, the patient can be treated in a shorter time, which has a positive psychological effect on the patient, iii) complications due to operations and immobilization are seen less compared consecutive sessions, iv) simultaneous bilateral procedure can reduce patient burden.

In Turkey, prevalence estimations for HV, bunionettes, and hammertoes were calculated as 54.3%, 13.8% and 8.9%, respectively, and positive family history rates were 53.2%, 61.2%, and 56.1% for the same case series, respectively, with associated deformities, which are more common in females (p<0.001). A study declared that constricting shoes might affect HV incidence in women (p<0.001) and bunionette incidence in both genders (p<0.01) [8]. It appears that the estimated prevalence of HV varies between 21 to 70% in epidemiologic studies [9]. Bilateral HV was reported to occur at a rate of 16.9% (6.0% in the left foot, 7.0% in the right foot; p<0.001) and at a rate of 21.2% in women (7.6% in the left foot; 8.2% in the right foot), and 11.0% in men (3.9% in the left foot; 5.4% in the right foot) [10,11].

Over time, mini-invasive techniques have become more popular for HV surgery because they are associated with reduced patient anxiety related to anesthesia. As the first serious book study about minimally invasive foot surgery in the literature, De Prado's book described these less invasive techniques; the author also discusses an algorithm that has been defined as surgical operation on only one foot at the same time [12]. With the exception of Carvalho's study, there are currently no studies on the simultaneous bilateral correction of HV [13]. Reverdin-Isham, a distal metatarsal osteotomy, was associated with revolutionized correction of simple to severe hallux abducto

valgus deformities, which was done after the exostectomy [14]. The authors declared that this modification provided a successful, minimal disability in daily life, a cost-effective method as minimal incision surgery for HV surgery. Recently, many studies have outlined the advantages of minimally invasive and percutaneous techniques for orthopedic procedures [15-17]. Carvalho et al investigated differences between minimally invasive percutaneous operations for one foot versus both feet at the same surgical time [13]. Arthroscopy and percutaneous mini-incision (1–3 mm) osteotomies were performed for these minimally invasive HV techniques. They emphasized that the simultaneous bilateral percutaneous HV surgery could provide the same results as a unilateral operation, and therefore, recommended one-stage HV surgery because of socio-economic reasons [18].

Our study is the first study about single-session bilateral HV surgery according to our literature review. Our study also sheds light on this subject, which is constantly wondered, in terms of cost-effectiveness. However, the limitations of our study were as follows: 1) the number of patients was limited, 2) the study design was retrospective, which had inherent limitations, 3) the follow-up was relatively short, 4) in terms of cost-effectiveness, a much more qualified study could be done with the help of relevant economics disciplines, 5) a comprehensive study could be done in the form of a meta-analysis involving much more medical centers.

Conclusion

Our findings here have emphasized the following: (1) postoperative complications in the groups were similar with both methods, (2) both groups had similar clinical outcomes and ROMs, (3) FAOS scores had slightly better courses in consecutive operations, (4) the simultaneous bilateral procedure decreased hospitalization and total hospital costs, (5) from an economic point of view, the simultaneous bilateral procedure has meaningful financial advantages.

The simultaneous bilateral procedure is safe and resulted in similar post-operative toe functions compared with the consecutive procedures. The simultaneous bilateral procedure had some advantages such as single anesthetic exposure, lower medical costs, and shorter hospitalization. Complications due to operations and immobilization of a simultaneous bilateral procedure are less than consecutive sessions. Consecutive procedures doubled the costs of anesthesia and complication rates. However, consecutive operations had better functional outcomes compared to the simultaneous bilateral procedure in FAOS evaluations. QOL was higher in consecutive HV surgery procedure patients.

The simultaneous bilateral procedure has positive psychological effects on the patient with shorter hospitalization duration time. Also, the simultaneous bilateral procedure has advantages because of reducing the patient burden. Our results indicate that simultaneous bilateral procedure had the cost-saving feature and therefore we conclude that this procedure may be more optimal for healthy patients due to economic reasons and its features of minimally invasive operation.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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